RAILWAY ENGINEERING
and Maintenance of Way

Published by the
BRUCE V. CRANDALL COMPANY, CHICAGO

BRUCE V. CRANDALL, President, CHARLES S. MYERS, Vice-President
O. W. BODLER, Secretary
O. H. REYNOLDS, Editor WARREN EDWARDS, Manager

Office of Publication, Rooms 409-410 Security Building, Corner Madison Street and Fifth Ave., Chicago
Telephone - - Main 3185.

Eastern Office: Room 714, 132 Nassau Street, New York City
Telephone - - 3524 John.

A Monthly Railway Journal

Devoted to the interests of railway engineering, maintenance of way, bridges and buildings.

Communications on any topic suitable to our columns are solicited.

Subscription price, $1.00 a year; to foreign countries, $1.50, free of postage. Single copies, 10 cents. Advertising rates given on application to the office, by mail or in person.

In remitting make all checks payable to the Bruce V. Crandall Company.

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Entered as Second-Class Matter April 13, 1905, at the Post Office at Chicago, Illinois, Under the Act of Congress of March 3, 1879.

VOL. II CHICAGO, JANUARY, 1906 NO. 1

THE average cost of roadbed and track maintainance per year is scarcely realized by those not given to the statistics habit, but it is a fact according to the report of the Interstate Commerce Commission, that the expense of renewal of rails and ties per mile of track, together with necessary labor for upkeep of roadbed, is $900 per year, or $188,000,000 for our railway systems. Of this immense sum, $17,395,000 goes for rails, $139,213,000 for general maintenance cost, while $31,213,000 represents the outlay for ties.

Electrification on the New York Central

THE work of electrification of the New York Central properties is going on with a progress that betokens an early installation of the new power. The expose of the situation, recently given by President Andrews, of the Mohawk Valley Company, explains the present status of the work, also the outline of activity for the future. The report is as follows: Plans are being prepared to equip the Auburn road from Syracuse to Rochester with electricity. The Rochester & Eastern will be used whenever possible. The same plans provide for the use of electricity on the Suspension Bridge and Rochester division, commonly known as the Falls road, and running from Suspension Bridge to Ames Street Junction, Rochester. Niagara Falls power will be used, and in some places an additional track, and even two additional tracks, will be laid to care for the electric cars. Work is to start in the spring as soon as frost is out of the ground."

In this connection it may be of interest to read that on Dec. 15 the West Shore road was opened to regular electric service between Utica and Little Falls, 22 miles, using an equipment of eighty trolley cars per day, which will hereafter run over the electrified portion of the steam road. This is the first section of the West Shore to be electrified, and it is expected that within one year the road will be used in trolley service between Utica and Syracuse, as much of the work necessary to electrification is well advanced. The work is thus seen to be prosecuted from both ends, leaving the central gaps to be filled, and these are of minor consequence when it is considered that no work is necessary on the roadway. At the rate of progress now being made, it will be but a short time when choice can be made between steam and electricity from Albany to Buffalo.

The Hudson River Tunnels

NEVER before in the annals of tunneling a river of the width of the Hudson has the work been prosecuted so quietly and surely as in the case of those of the Hudson County (New Jersey) Rapid Transit Company. The bores are completed between Jersey City and New York—as tunnels—and all that remains to be done to make them ready for traffic is the rails and equipment to make the wheels go round. This work was expedited by the fact that one of these tunnels was partially completed and afterward abandoned as an impracticable proposition. This was about thirty years ago, and of course before the days of electric traction This pair of tunnels is not only completed from shore to shore, but remarkable progress has been made toward their junction with the Pennsylvania tunnels on the New York side, they being well under way from Morton street (the New York end of the tunnel under the river) as far north as Bleecker street.

The construction of this tunnel has been a most remarkable feat of engineering, in the sense that no knowledge of its progress was had by the property interests along its course, so free was the whole project from the troubles encountered by the Subway. It was completed before any one had any knowledge of it. The connections on the New York side will embrace the Interborough and also the Pennsylvania cross-town system to Long Island, enabling a passenger from Jersey to reach any part of the boroughs of Manhattan, the Bronx or Queens.

When the whole tunnel system is completed, there will be presented a combination of traction facilities that will be found in no other metropolis, for there will be five transportation levels in Herald square. First of all is the Manhattan Elevated, and below that is the Metropolitan Street Railway at street level. Below that will be the New York & New Jersey tunnel, and still below that will be the proposed West Side Rapid Transit Co.

of New York; below that, and lowest of all, will be the Pennsylvania tunnels now under way, to connect New Jersey with Long Island. The Hudson County tunnel entrances on the Jersey side will connect by a subway between Jersey City and Hoboken, which will pass under the tracks of the various railroads' stations at those points, which are located on the river front. It is a sign of progressive times when roads work in unison for the comfort and convenience of passengers, as is now being done in the case of these enterprises under different managements.

Ferro-Concrete Practice

IN the paper read before the Institution of Mechanical Engineers at Liege, the author, Mr. E. Noailles, brought to view some facts in the practical application of ferro-concrete to various engineering projects, that is not of common knowledge in this country, and which should lead to the adoption of a better understanding of the different members of a structure when subjected to similar stresses. A brief abstract of some of the most vital points presented will be in order at this time.

After reference in the paper to the remarkable properties of concrete, among which were the economy rendered possible by its use as compared with other competitive systems, and also its resistance to fire, which is now put beyond doubt by numerous tests, some made for the purpose and others by accident, mention was made of it as the only flexible material which possesses the quality of fire resistance. In addition to this important fact, the author went on to say that it is unaffected by atmospheric action, concrete being from this point of view comparable with stone of the best quality, and it improves with age.

And again: As to the metal built into the concrete, it has been proven that it is perfectly preserved without loss of weight, and that even if used in a rusty state, it will recover after some time the bluish tint which it possessed when leaving the rolling mill. This incredible result being due to the chemical action of the cement and probably to the formation of a protective coating of silicate of iron.

Concrete also resists equally well the effects of corrosive fumes and liquids which are feebly acid. Mild steel is almost exclusively used at this time, having an ultimate tensile strength of twenty-seven tons per square inch. Round bars are generally used, as they facilitate the escape of air and the proper ramming of the concrete; they also possess no sharp angles which would cut the concrete, but, on the other hand, the round section gives the lowest coefficient of adhesion for a given cross section of the metal.

The author quoted Professor Rabut, who has summed up in the following six rules the principles which experience and theory recommend should be followed in the construction of ferro-concrete buildings. The principles capable of universal application and of special interest are as follows: No connections should be made of iron to iron, as the concrete itself holds the parts together in the most economical manner. At least two distinct systems should be used, the one system to take up the tensile stresses, and the other to take up the shearing stresses in the concrete. Where it is necessary, a third system should be used to take up the compressive stresses. The reinforcement should be so arranged that the separate members may be stressed in the direction of their length, so that the stresses produced between the iron and concrete shall be tangential, and not normal to the axis of the members of the reinforcement.

To profit by all means of increasing the homogeneity of the various parts of the structure, may be done by prolonging the iron parts of one portion of the structure into the thickness of the concrete of the adjoining portions at a negligible cost, while the construction of rigid joints in a metallic structure is very expensive. On the other hand, advantage should be taken to the utmost extent of the homogeneity thus obtained to economise materials. In view of this homogeneity, sudden alterations to the cross sections of the parts should be avoided, as the parts tend to assist one another and to distribute the stresses, the constitution of ferro-concrete being, so to speak, democratic.

The component parts of a ferro-concrete structure may be classed under three headings, which, examined in turn, are: The parts which resist tensile stresses; those which resist compressive stresses, and those which resist more complex stresses. These comprise chiefly the beams and the platform beams. In the majority of cases the beam supports a platform which is solid with it and can therefore be used as a framework in compression; and this is one of the characteristic properties of ferro-concrete. The beam is therefore really composed of the rib and the part of the platform on each side and this has a cross-section in the form of a T. The tension member consists of one or several metal bars embedded in the lower part of the rib.

The materials are therefore used in the most rational manner, the concrete of the platform is subject to compression, and the metal resists tension; but this specialization of work is only possible owing to the adhesion of the concrete to the metal. In reality there are forces tending to produce sliding, and these are proportional to the shearing forces, and therefore attain their maximum value near the supports. These forces tend to shear the concrete of the rib, and are concentrated at the contact surface of the concrete and metal. The mutual adhesion of these two materials is of very great importance, and it is well to bear this in mind. Numerous tests have shown that a in carefully built structure this adhesion is not of lower value than the shearing coefficient of the concrete itself. If, however, the concrete be very poor in cement, or if it has been gaged too dry and insufficiently rammed, then the adhesion may be low, and the use of bars of special section has advantages, these bars having projections which prevent all slipping of the metal in its concrete sheath. Such bars are very commonly used in American practice.

Adhesion does not only assist in resistance to shearing

stresses, but the variations in relative volumes of the two materials in contact must be considered, these variations being caused by change of temperature, or by shrinking of the concrete. Temperature has no influence, for the coefficients of expansion of iron and concrete are practically the same. When concrete sets in air, it contracts, and, therefore, may produce considerable initial compression upon the embedded metal, whilst being itself subject to an equivalent tensile stress. When concrete sets under water, the opposite effect is produced; the concrete expands and puts the metal in tension. It is important that the shearing stress should neither overcome the adhesion of the metal to the concrete, nor shear the rib of the beam. To fulfill the first condition it is necessary to form the metal framework of such a number of bars that their surfaces in contact with the concrete shall be large enough and, in consequence, the chance of surface clips shall be reduced. To avoid the shearing of the rib, special stirrup-shaped bars are used, which join together the two members. It is not correct to state that these stirrups directly resist the shearing stress. In reality, a piece which is under shearing stress throughout its entire length, is by that stress subject to bending, but the stirrups have no rigidity, and are incapable of resisting any appreciable bending movement; as a matter of fact, they fulfill the same purpose as the tension bars in the web of a lattice girder. The duty of the compression bars is fulfilled by the concrete of the rib. It is, therefore, obvious that it is essential for the stirrup to be hooked at one end to the tension bar, and at the other end they should be solidly embedded in the concrete platform.

The author has pointed out that one of the characteristics of concrete is to lend itself easily to continuity of structure; but it is clear that this may have the effect of displacing, toward the bottom, the diagram of bending moments in such a way that near the supports certain reversed moments may be of higher value than the moment at the center of the span. From this cause tensile stresses are produced in the top member and compressive stresses in the bottom member. In order to overcome the first set it is necessary to provide new reinforcement, if it does not exist in the upper member, or raise the lower reinforcement toward the top of the beam, which has also the advantage of neutralizing the tendency to sliding, as has already been pointed out. To overcome the second series, the concrete of the lower part of the web is often insufficient, and then the lower reinforcement is used at this point in compression. Another method coming into use consists of banding the concrete of the web, which considerably increases the resistance to crushing. When the reversal of moments is due to the continuity of the beam and the floor platform, the use of reinforcement in the upper part is not always necessary; in fact, the platform may then play the part of the member in tension, owing to the distributing bars which it contains, and to the resistance to tractive efforts of the ferro-concrete itself. When the beams have no continuous platform they should be provided with compressive reinforcement, or be banded.

Mons. Considere has shown that ferro-concrete can be extended without cracking, until the reinforcement reaches the limit of elasticity, and that the part of the resistance due to the concrete, attains after the first extensions, a value which remains constant until rupture occurs. It is evident that if this result is to occur, the piece must be free from all cracks before the test, and to obtain this condition special precautions must be taken in its manufacture and setting. Excess of moisture must be avoided in gaging, ramming must be carefully done, and the piece must be kept moist during the first days of setting. As has been seen, it is most frequently impossible to determine accurately by means of theoretical formulas the actual cross-sections of reinforcement. The best guide is experience translated as well as possible into empirical rules. These rules will be all the more reliable according as they are based on larger number of structures, and from this point of view it is best to prefer the systems which have been the most employed in practice.

Electrification of the New York Central Suburban District

THE work going on for the electric service of the New York Central Suburban lines out of the City of New York is one of the greatest electric transportation problems ever carried out, and is now nearing completion. A reference to the plan of the work shown in Figure I, will reveal the extent of the electric zone in which the new power is to be used, showing a district of over 50 miles. This scheme has been carried on over a period of three years, and involves the change from steam to electricity, of the line on the Harlem division to North White Plains, and to South Croton on the Hudson division, which are the teminals of the electrified zone, and each of which lines has four tracks.

Power is furnished the electric zone by two generating plants, one of which is located at Port Morris in the borough of the Bronx, New York City, and the other at Yonkers, New York. The Port Morris station is shown in section in Figure 2. The two stations are duplicates in all essential particulars. The current generated at these stations is three-phase, twenty-five cycle, at 11,000 volts, and is carried to the eight substations of the divisions, where it is transformed into the direct current of 660 volts for use in the third rail.

The substations, one of which is shown in Figure 3, are located, one at the Grand Central Station, one at Yonkers, and the others at various points on the lines, all of which are indicated by numbers on the plan. The power equipment at these stations is variable, provision being made as shown for eight rotary converters, three of which only are to be installed at this time, and to be of 1,000 K. W. capacity each, except those at Nos. 1 and 2, located at the Grand Central Station and Mott Haven respectively, which are to be of 1,500 K. W. capacity. At each substation, there is an insulated section of several

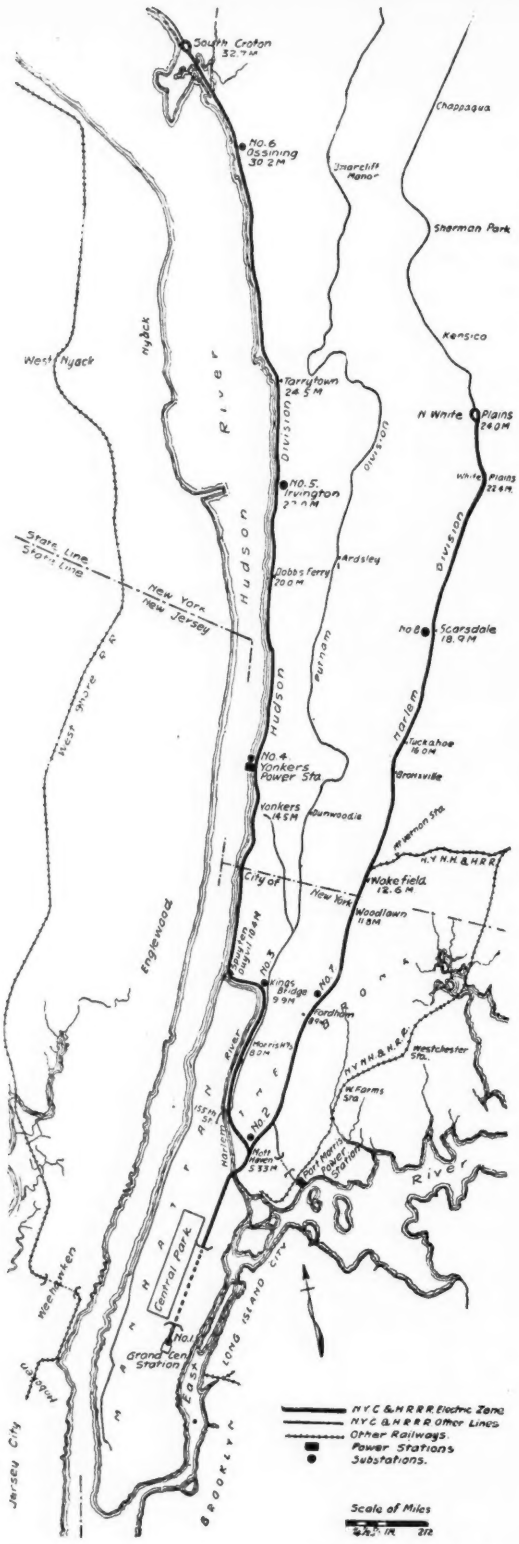


FIG. 1. PLAN OF NEW YORK CENTRAL ELECTRIC ZONE

hundred feet (about a train length), which is broken from the third rail at each side of same to prevent trains from bridging between sections; the insulated section receiving its current by its feeder to the substation. There are eight feeders to the third rail outside of the insulated section, coming from each of the two sections of the four tracks. In addition to these feeders, there is auxiliary feeder connecting with the third rail every 3,000 feet. All of these connections are controlled by a circuit breaker from their adjacent substations.

Transmission of power from the generating stations and substations, is in general an overhead line carried on steel towers. In New York City for obvious reasons, the underground system is installed. The substations are the points at which the changes from overhead to underground transmission are made in most instances, but in some cases this is done by means of cable towers, one of which, near High Bridge, is shown in Figure 4. This system of transmission is designed to give the greatest protection against interruption of any character. Each substation may be fed from either power station, and the lines are so disposed that no ordinary combination of circumstances usually productive of disaster, can cut off a substation from its power supply.

An under contact third rail will be used. The rail is of special bull head section, 70 lbs. per yard, with high electrical conductivity. It is supported by cast iron brackets bolted to long ties spaced eleven feet centers. Insulators fit loosely over the top and web of the rail, thus allowing some vertical play. A clamp fits around the side and top of the insulator and is bolted to the bracket. The top and sides of the third rail will be covered with insulating material to give thorough protection against accidental contact. This insulation and method of support and of contact of the third rail is shown in Figure 4.

In the design of the substations, the most careful attention has been given to the following considerations: The path of the energy must be as direct and short as possible from the high tension transmission lines to the D. C. feeders. The wiring to be as little exposed as possible, and yet be readily accessible. All machinery to be on the same floor as the operating boards. The principal apparatus to be under the direct control of the operator while standing at the operating boards. All apparatus and machinery to be arranged so that the effects of an accident will be confined to the place where it occurs. The risk of accident to the operator to be as slight as possible, and the stations to be fireproof.

In pursuance of the first condition, the apparatus is arranged in the following order across the stations: Entrance of high tension lines, high tension switching apparatus, transformers, rotary converters and direct current switching apparatus. Along the station there is a succession of complete units, such as that described in the foregoing, the controlling apparatus being located at the center. The second requirement necessitated the use of wall chases for the high tension lines, and determined the use of transformers having both high and low tension terminals underneath the main floor. The third requirement determined the omission of galleries except for lightning arrestors. The fourth requirement introduced the use of electrically operated switches and cir-

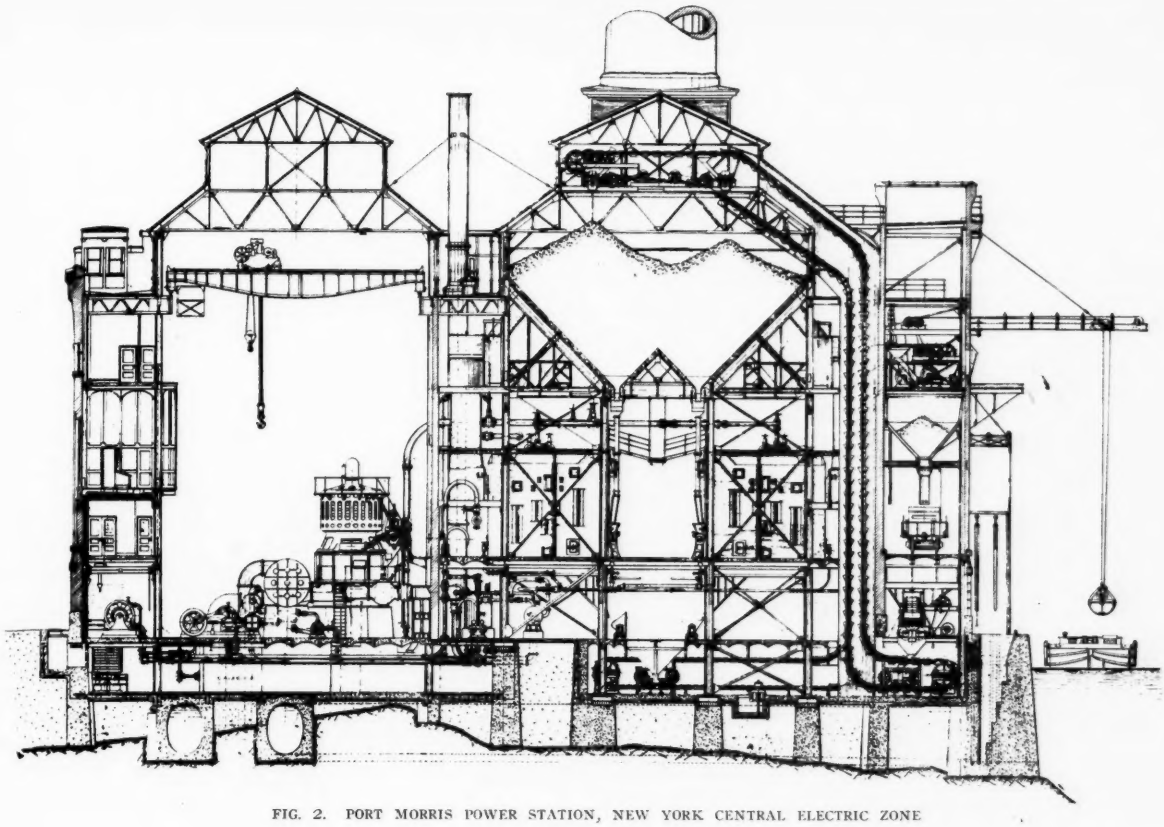


FIG. 2. PORT MORRIS POWER STATION, NEW YORK CENTRAL ELECTRIC ZONE

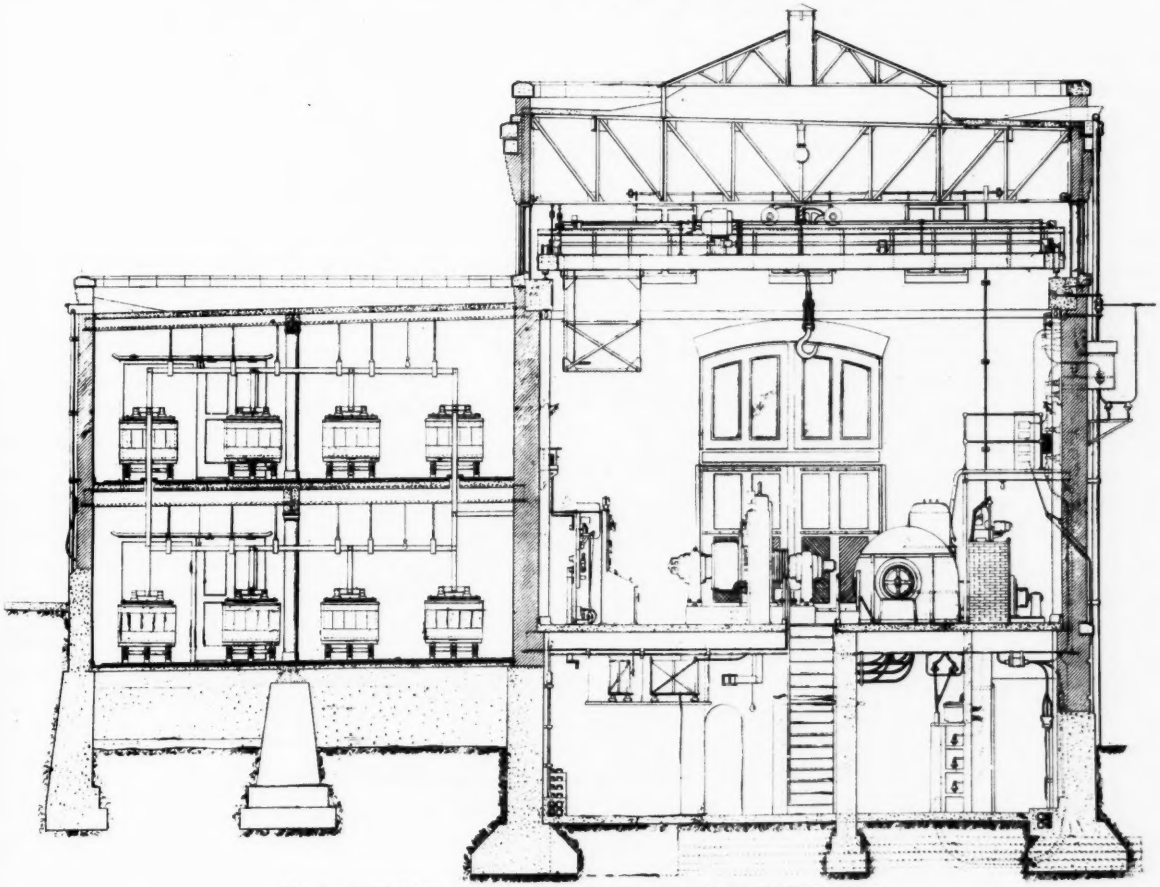


FIG. 3. NEW YORK CENTRAL TYPICAL SUB-STATION IN ELECTRIC ZONE

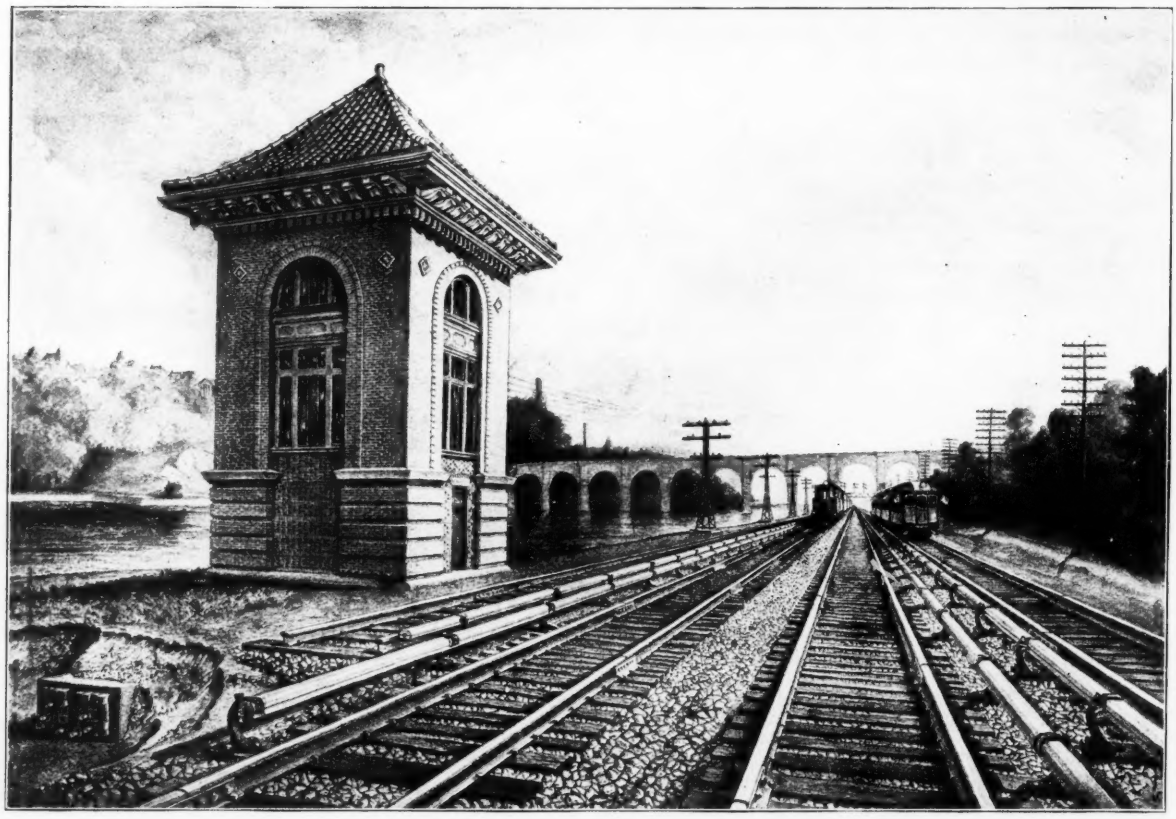


FIG. 4. NEW YORK CENTRAL CABLE TOWER AND TRANSMISSION SYSTEM IN ELECTRIC ZONE

cuit breakers for both the high tension alternating current and the low tension direct cuurrent. All of these switches and circuit breakers are operated from the control boards. The fifth requirement settled the ample spacing of the machinery, and introduced a very complete system of barriers for the protection of live conductors, an arrangement which is of great service in protecting the operator from danger.

The power stations are designed to be equipped with six 5,000 K. W. turbo-generators of the Curtis five-stage vertical type. The turbines are mounted upon a cast iron base, which has the function of an exhaust chamber, and has communication with the conductors, or the atmosphere as required. The turbine shaft is arranged to connect with that of the generator by means of a coupling, and is carried on a step-bearing of cast iron, the shaft and step being lubricated by water under a pressure of 800 lbs. per square inch, furnishing a novel and effective relief for the load on the bearing.

The steam plant at the power stations consist of a battery of twenty-four Babcock-Wilcox water tube boilers of 625 H. P. each, located in rows of twelve each. The total heating surface of each boiler is 6,250 square feet, and they are designed for a working pressure of 185 lbs. per square inch. They are also to furnish superheated steam to 200 degrees Fah., above the temperature due to the boiler pressure, or about 590 degrees. There is an Epping-Carpenter boiler-feed pump of the duplex outside piston type assigned to every four boilers of the plant.

The coal is delivered to the boilers by vertical spouts, and fed to the grates by Roney stokes. Ashes are disposed of by passing from the grates into hoppers which are emptied into push cars of one ton capacity which are operated in the tunnel provided for them underneath the boilers, the cars dumping their loads into a spout leading to cars which transport the refuse from the plant. The coal is delivered from the cars into pockets from which it is conveyed to the crushers and reduced to a size to be readily handled by the mechanical stokers, from which point it passes to the top of the boiler house and goes to the boilers by gravity. The construction of the power houses, while not architecturally on severe utilitarian lines, have been well designed to suit their purpose, and at the same time are structures pleasing to look upon.

The work here outlined is under the charge of Mr. W. J. Wilgus, Vice-president of the New York Central by whose courtesy our illustrations and particulars are given. The details described in this article have been worked out under the direction of Mr. E. B. Katte, Electrical Engineer.

The Steel Tie

IN the consideration of the important question of track improvement, the scarcity, if not the inadequacy, of wooden ties, in the performance of the duties devolving upon them, is one of the principal factors which constantly obtrudes itself upon the attention of railroad engineers throughout the country. That wooden ties are growing scarcer as the years go by in consequence of the denudation of the forests, and that this scarcity necessarily means an increase in their cost, is almost superfluous to assert. But perhaps the most important consideration in this connection is not so much the scarcity of the wooden tie as it is the inadequacy of that article to meet the demands of modern railroading, where improvements have reached out in every direction, except in that of the tie. How much longer are we going to be contented with a track composed principally of wooden ties, into which, in order to attach the rail thereto, so flimsy a thing as a spike has to be driven—the only fastening which up to the present time the ingenuity of the railroad people of the United States has been able to devise to insure the safety and efficiency of the track?

If we look into the subject with that degree of care which it unquestionably warrants, it must be obvious that a metal track is the only thing which the future will present to us as guaranteeing permanency and stability of the roadbed. That steel ties afford a proper and suitable material such as is required for this result, many years of experimenting have demonstrated, for not only in this country but also in Europe and elsewhere, the steel tie, though the form has not always been the same, has been found entirely satisfactory in itself for all the purposes demanded of it. In the United States the question as to the shape which the steel tie should assume is no longer, however, a puzzle to engineers, as the 67,000 I-beam ties scattered here and there in sample lots throughout the country bear very weighty witness. Indeed it is more than likely that a vastly larger number than this would have been in use long ago, had it not been that until recently the fastenings used to attach the rail to the tie were not of that high standard of excellence which a metal tie construction is obliged to demand. This great difficulty has recently been entirely removed, for within the past few months the railroad world has witnessed the introduction of a system of fastenings which combine in themselves the indispensable qualifications of durability, simplicity, adjustability, neatness, and cheapness. These ingenious attachments are the property of the Truss Steel Tie Company, of Pittsburg, Pa., which has been devoting its entire time and attention for more than a year past, to the introduction of the metal tie vs. the wooden one, and which has succeeded in demonstrating, wherever a piece of its equipment has been installed, that the fastenings are absolutely adequate to the requirements demanded, and are in every respect entirely satisfactory.

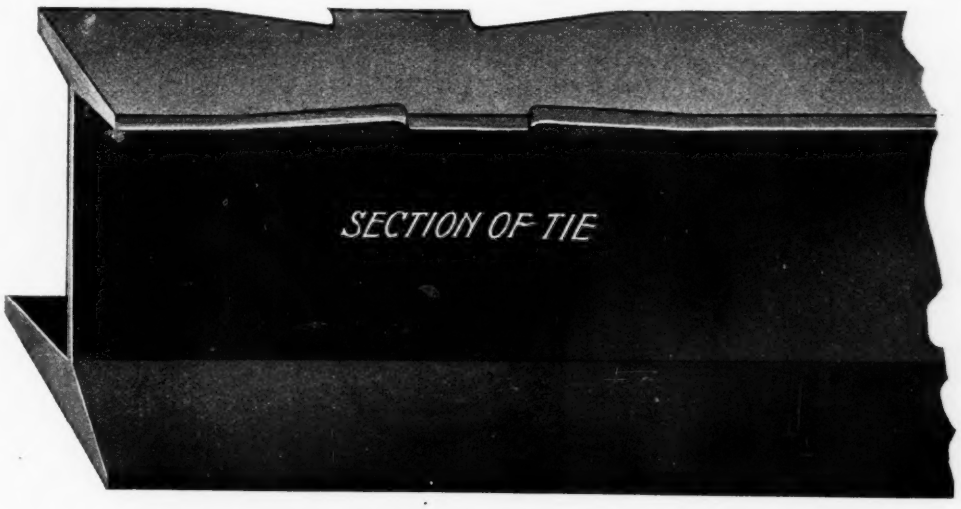


FIG. 1. SHOWING I-BEAM CUT OUT, WITH WIDENING ANGLES—STEEL TIES

A glance at figure 1 of the illustrations accompanying this article shows the I-beam cut out with widening angles outward on each side of where the rail crosses the tie, and demonstrates the frictional principle upon which the clip and the hook bolt shown in figure 2, when properly tightened up with a nut, holds the rail to gauge without the possibility of slipping, owing to the constantly increasing angle in the tie which widens outward from the flange of the rail and forms in this particular a perfect wedge. This clip and hook bolt is absolutely all there is to this mode of fastening (the attachment being applied of course to non-insulated ties), and the strength of the device as well as its adjustability and simplicity becomes at once apparent upon inspection. No "rights" or "lefts" are required, and no mistake can be made in attaching the fastening to the rail, while probably nothing could be devised which is more easy to put on or to take off when required. The clip and the hook bolt have a play along the flange of the head of the tie in the cut angles of at least an inch on each

side of the rail and at both ends,—making four inches in all,—in every respect being amply sufficient for mobility in going around curves or for alteration in the size or weight of the rail. That this is the ideal fastening where non-insulated ties are required surely demands no argument, for actual experience has shown that wherever these fastenings are used the most satisfactory results have been invariably obtained. Perhaps one of the most ingenious features of this simple attachment is the position in which the hook bolt lies along the top of the tie, conforming itself to the philosophical principle that a nut lying in a horizontal plane will not be turned or jarred by vibration to any such extent as it will when lying in a vertical one, as is the case where the bolt runs perpendicularly through the tie to hold a clip to the rail at an arbitrary point or through an arbitrary hole. Indeed, experience with this system has shown that where these fastenings have been used for over four months, in no single instance has it been necessary to tighten up the nuts, though the fastenings have been subjected to some tremendous strains, particularly where heavy tonnage on difficult and severe curves has tested their merits to an unusual degree.

Figure 3 of the illustration shows this same system of angles as applied to the principle of insulated ties made necessary as a safeguard against the electric current where signals are given along and through the rail. In this connection of course absolute safety from leakage is indispensable, so that the current shall not be short-circuited across any of the ties; and it will be seen at a glance that the ingenious arrangement of movable wooden blocks to entirely insulate the rail and at the same time to accommodate itself to the feature of adjustability in every way meets this requirement. The clamps which hold the blocks in place are but a modified form of the clip and hook bolt in use in the non-insulated plan. and are held in place by bolts in a similar manner, their protection from slipping, as in the other instance, being the widening angles cut in the tie against which, working backward from the rail, they form a perfect wedge.

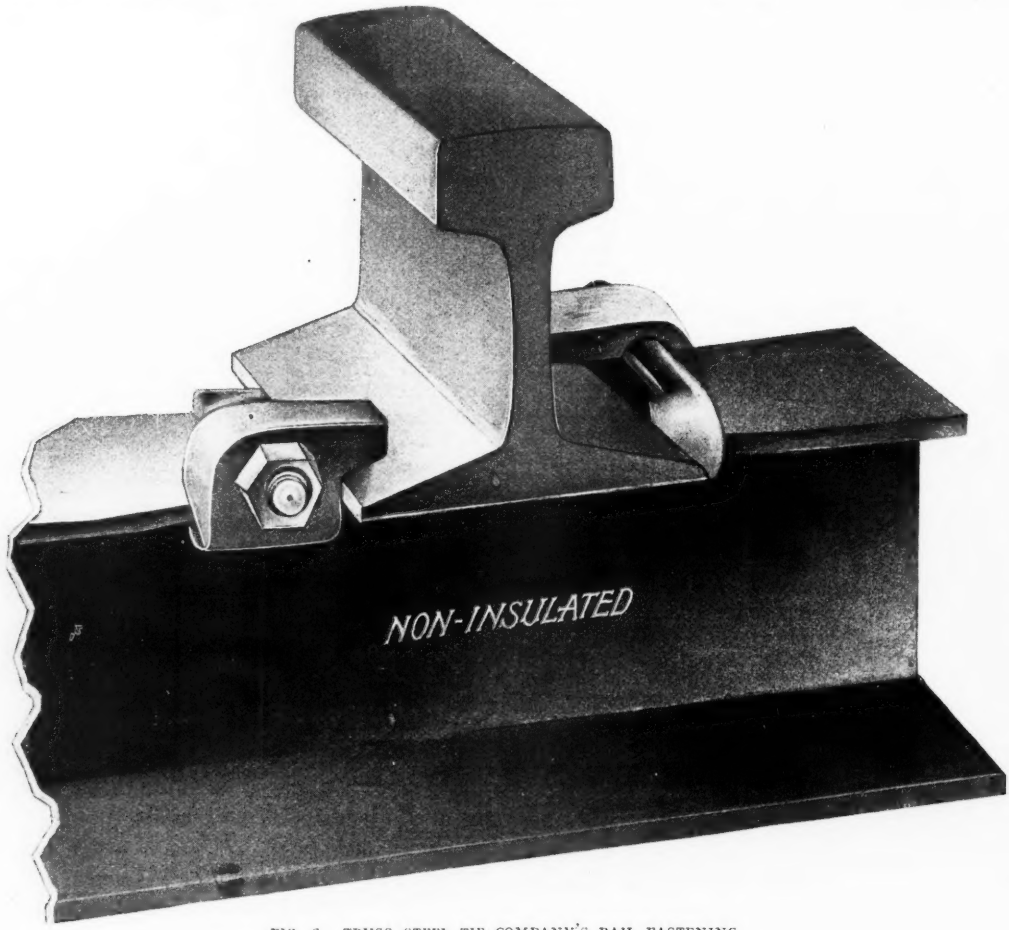


FIG. 2. TRUSS STEEL TIE COMPANY'S RAIL FASTENING

Taken all in all, it may be said that with the new fastenings of the Truss Steel Tie Company as applied to the I-beam, the day of the steel tie is here. One of the best-known civil engineers of the country, Mr. S. Whinery, of New York City, who has devoted a great deal of time to the subject of steel ties, commends the I-beam shape emphatically and proves that this form is in every respect the desideratum of the modern railroad. In a lengthy and learned article given to one of the New York papers not long ago, he said:

"Many experiments have been made abroad and not a few in this country with cross-ties taking the general form of steel or iron beams. But the section adopted

has not been, as a rule, one to develop the greatest strength per unit of area of metal used. An inverted trough or channel has been most frequently chosen. It may be readily shown that this section does not afford an economical disposition of the material used. Everything considered, the common I-beam may be taken as the general form which, with the load acting through and parallel to its web, develops the greatest strength per unit area of metal used. We may, therefore, reasonably assume that if it lends itself to the purpose equally well in other respects than strength, it is the most promising section to use in designing a metal cross-tie."

Supplementing this statement with another in the same article, Mr. Whinery claims that the I-beam should come into general use by railroads because "it has a sectional area of 40 per cent less and a moment of resistance of 40 per cent greater than any other form of steel tie which has so far been tried."

When Mr. Whinery's investigations were made (now over a year ago) the fastenings of the Truss Steel Tie Company were unknown, but since that time a number of railroads have been equipped with this system, most notably the New York Subway at 148th St. and Lenox Ave., New York City; the Pittsburg & Lake Erie R. R. at McKees Rocks, Pa.; and the Bessemer & Lake Erie R. R. at Euclid, Pa. In every instance the fastenings have proved to be all that is claimed for them and all the evidence at present to hand points to this Company having contracts to equip in the near future many other lines with its system.

The cost of the steel tie today is much less than when Mr. Whinery wrote his famous article, and at that time the modern fastenings here illustrated were not in existence to recommend themselves to the railroad world as strongly as they do today. When we take into consideration the total cost of the steel tie, which is only about $2.50 including the fastenings, and compare its life (not less than 30 years with scarcely little or no cost of maintenance during that time) with the life of the wooden tie, which will not average over six years, we may express amazement perhaps that the railroads of the country should hesitate to use such a splendid substitute for the constantly scarcer and dearer wooden article. As a simple investment of money, were the conditions relating to cost equal, it would still be wise to use metal ties instead of wooden ones on account of the vastly superior character of the material, the safety which it affords and its absolute reliability; but where the conditions relating to cost are in favor of the steel tie (as they certainly are) and the other features are taken into consideration, there should no longer be any hesitancy on the part of railroads which desire first-class modern equipment to give the new system a substantial trial.

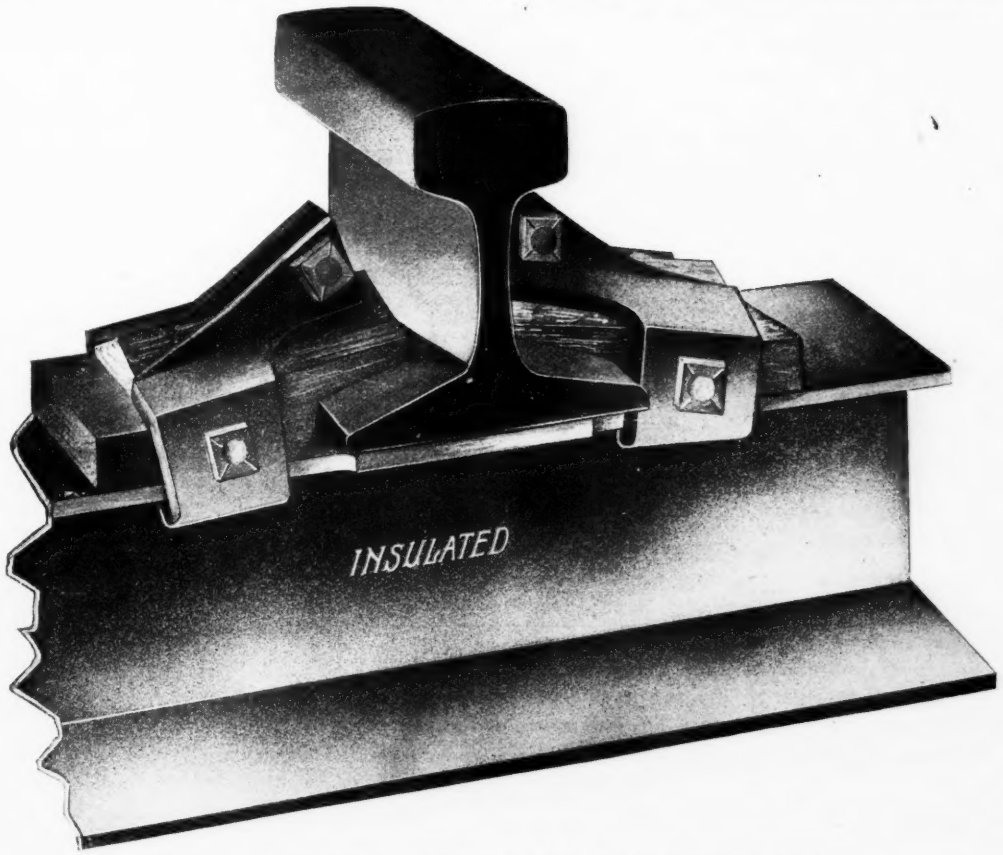


FIG. 3. TRUSS STEEL TIE COMPANY'S RAIL FASTENER APPLIED TO INSULATED RAIL

Baltimore & Ohio Station at Youngstown, Ohio

THE new passenger station of the Baltimore & Ohio Railroad at Youngstown, O., which was recently completed, is built in the antique German style. It is 148 feet long by 50 feet deep, and is two stories high. The tracks are on a level with the second story, leaving the railroad facade one story in height. A wide driveway of limestone with a 10 ft. cement walk, fringed with a lawn and flower beds, leads from Mahoning avenue to the station.

The building is constructed of gray pressed brick, with brown sandstone trimmings. The interior is finished in white oak with marble mosaic floor in the main waiting room. The floors of the other rooms are finished with maple. The roof is covered with red tile of Spanish design. The platforms between the tracks are cov-

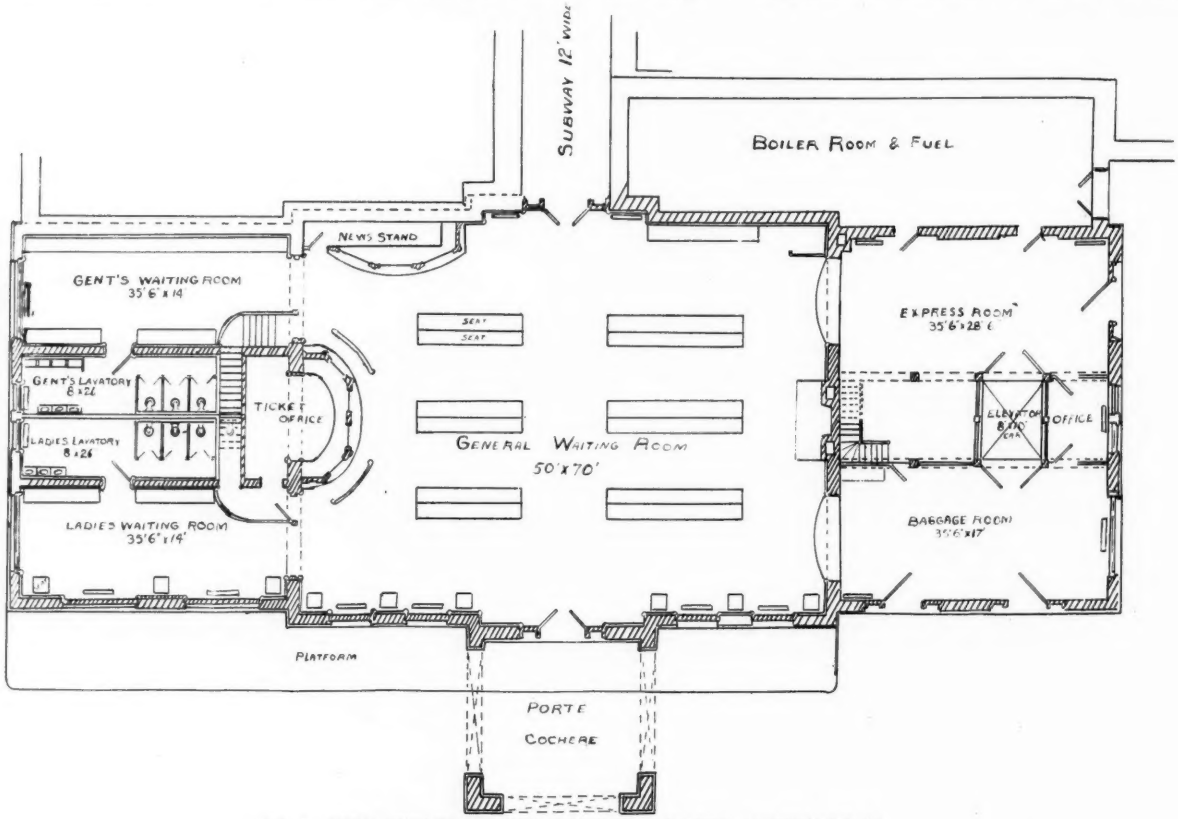


FIG. 1. FIRST FLOOR PLAN, BALTIMORE & OHIO STATION AT YOUNGSTOWN

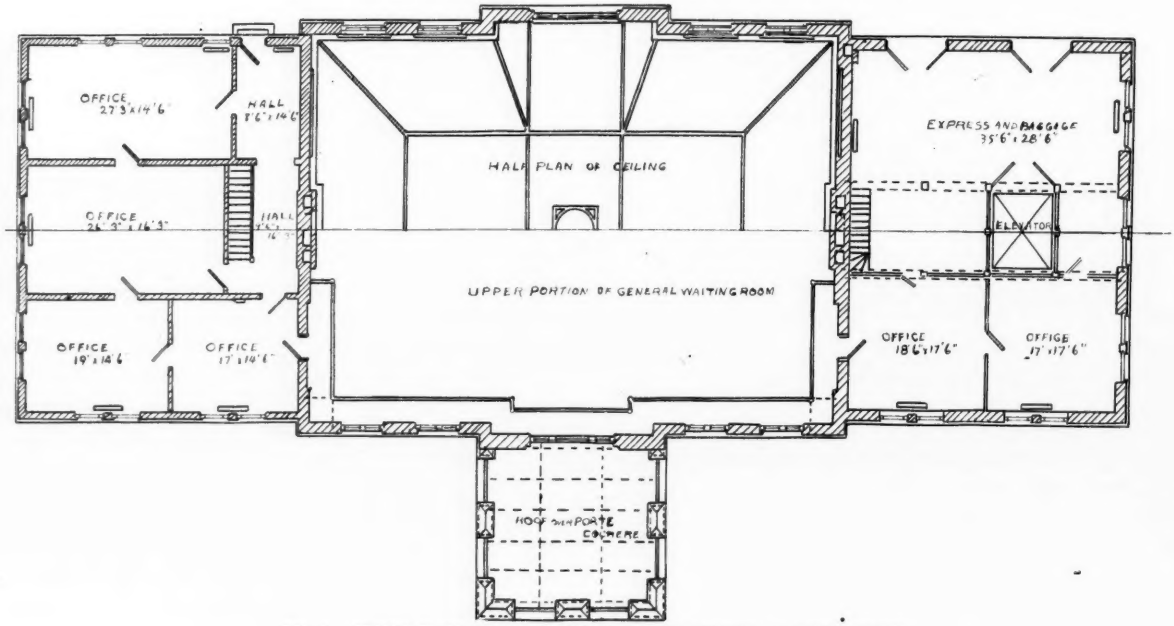


FIG. 2. SECOND FLOOR PLAN, BALTIMORE & OHIO STATION AT YOUNGSTOWN

ered with steel umbrella sheds covered with red tile roof.

The general waiting room occupies the center of the building and is two stories in height, with accommodations for seating 150 people. Connecting with it on the main floor are the ticket office, news stand, telephone and telegraph booths, express, baggage, gentlemen's and ladies' waiting rooms. The second floor is for offices and also a portion for express and baggage. The latter room is connected with the first floor with an 8x10 foot elevator. There is a subway leading from the general waiting room to each track, which relieves passengers of the necessity of crossing the tracks in going to and from trains.

A British View of the Third Rail

A WELL directed jolt has been administered to the conservatism of engineers who are loath to see any merit in practice that is at all strange to well anchored traditions, by the illustrious electrician, Sylvanus P. Thompson, in a letter to the London Times. The language is plain and is so *apropos* to the obstructionist in other branches of engineering, that it is deserving of the widest publicity. The letter is as follows: "The old obstinancy of refusing to admit the virtues of anything that has yet to be tried, at any rate in this country (England), is characteristic of too many British engineers. They shut their eyes to the experience that has already been gained in single phase propulsion with overhead conductors in Germany, in the United States, in the Valtellina and in the Stubaithal. Only when an order is placed with the Westinghouse Company for 25 locomotives of 1,000 horse power each, which work with single phase current and dispense with the third rail, do they wake up to cry out that 'experience with the newer system does not justify a sweeping condemnation of the views held by British engineers.' Perhaps it does not, but it justifies a sweeping condemnation of those British engineers whose vision is limited to those 'views.' By holding narrow views they have done their best—or worst, to rivet on our British railways, regardless of the progress of invention, the dangerous, inconvenient and expensive third rail."

A New Idea in Railway Boarding Camps

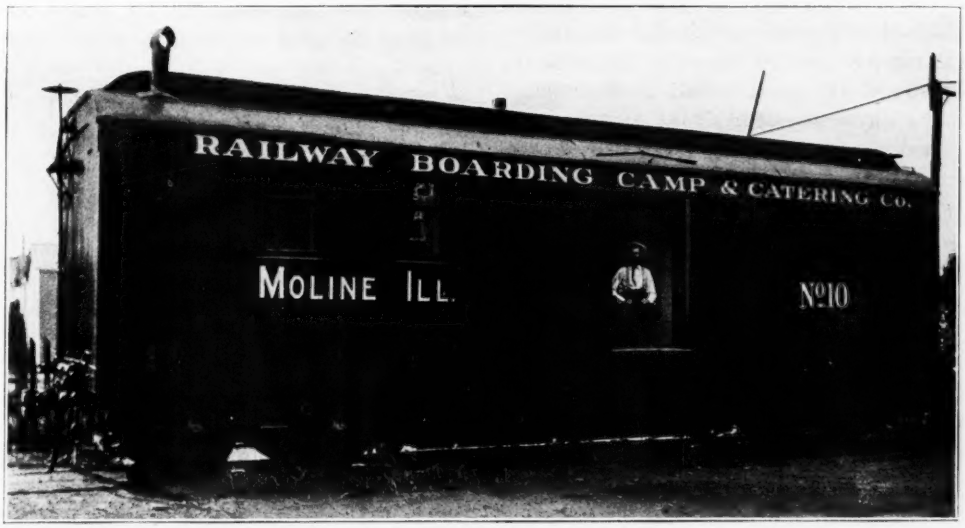
IT IS hardly necessary to dwell upon the many trying and disagreeable conditions which exist to the railway contractor who tries to feed and house a large gang of laborers.

The problem, while one that has been discussed but little in the technical journals, is nevertheless an important one. The principle that the better surroundings, moral and physical, men have, the more and better work they do, is generally recognized by large employers of labor, and this to such an extent that many large firms have gone to great expense to help their employes build houses that otherwise would be impossible for them to have.

The commissariat of the ordinary construction gang on railroad work is not always conducive to the content or comfort of the laborer. Too frequently the food is bad, he is compelled to sleep in cars poorly ventilated, on wooden bunks with a wisp of straw and a blanket for a bed. Fresh meat is too rarely provided, and the other comforts and accommodations are lacking.

Millions of dollars are annually expended in the construction of railroads. Such work calls for thousands of construction gangs of laborers. Railroads largely employ for such work laborers who are recruited in the middle East and Eastern States through employment bureaus. These men may be said, therefore, to be without a home, in so far as its immediate location is concerned, and depend as a result, upon the railroad companies for their food, shelter, clothing and incidental necessities.

The construction work being naturally in more or less unsettled parts, it is necessary for the railroad companies to prepare camps and run commissary trains to and from these camps, and to look after the maintenance and wel-



RAILWAY BOARDING CAR AT MOLINE, ILL.

fare of their workmen. This is a feature which is not desirable to railroad companies, as it requires a considerable amount of detail work, which they prefer to devote to their regular railroad business.

However distasteful, yet it is most necessary, owing to the fact that it would be impossible to take the men out to the scene of operations in the morning and to bring them back at night, for quite commonly there are no towns within a reasonable distance which could care for so many laborers; and even if this should be possible, the expense to the laborers would be too great; the annoyance of having to run special work trains would be too much; aside from which, the tendency of this class of laborers to desert their work on pay night must be overcome by keeping the men at the place of work until the work is finished.

In view of the opportunity such a field offers, the Railway Boarding Camp and Catering Company of Moline, Ill., offers a plan to better such conditions. While it is not a philanthropic scheme, the idea is to furnish much better accommodations for laboring men on railroad construction work at a cost not greater than at present obtaining.

The company was organized for this purpose by William M. Murphy, who is president and general manager, and has met with considerable success. The plan as it has been carried out is to furnish a complete boarding camp with which is a system of cold storage, so that fresh provisions may be kept on hand at all times and places. The car shown in the accompanying illustration is one of the cold storage plants. These cars were built especially for the company and are fitted with a cold storage compartment 14x8x7 feet, in which a temperature below freezing can be maintained. The refrigerating machinery which is in the car is operated by a gasoline engine made by the Root & Vandersant Gas Engine Company. The gas engine also operates a 3½-kilowatt Robins & Meyers generator which furnishes electric lights for the camp. The car is completely equipped for its purpose and can carry a large amount of fresh provisions designed to keep them so in any climate.

Sleeping accommodations for the men consist of the common box cars which are furnished by the railroad company, and usually sent to the shops to be fitted up with windows and wood bunks, which is a matter of some expense to the railway company; then when the construction work is done the same cars have to go to the repair shop and be resided before the cars can be put in freight service again. The Railway Boarding Camp and Catering Company has a portable arrangement to be installed in these cars consisting of an iron framework. On this framework wire mattresses with iron frames are used, giving plenty of room, clean and sanitary surroundings and plenty of ventilation. After the work is completed this portable arragement can be taken out and the cars put back in freight service without any overhauling.

Mr. Murphy, speaking of the plan, had the following to say: "Our camps are strictly up to date in every respect, being equipped with electric lights and the most modern method of cold storage, which is built expressly for us. All of our camp outfits are conducted on scientific sanitary principles and are in charge of a competent steward.

"We believe that by furnishing good, wholesome food properly cooked and served, also good, clean beds, kept in good condition, a better class of workmen can be secured and they will stay, and work better if they are satisfied with their board and accommodations. It is a well known fact that railroad companies and contractors have much difficulty in keeping men with them on construction work, particularly a desirable class of men. I believe that no one thing will do so much toward giving them such men as good accommodations.

"We are prepared to furnish these cars for summer camps and resorts and to operate, if necessary, hotels and stores for the benefit of large forces."

The Simplon Tunnel

THE Simplon Tunnel, intended ultimately to pierce the Alps between Switzerland and Italy, is interesting as the longest of the great Alpine tunnels. When completed, it will have a total length of about 12¼ miles, as against 9¼ miles for the St. Gotthard, and 8 miles for the Mount Cenis. It is distinguished from the other tunnels in the Alps by the fact that there are really two parallel tunnels, separated by about 55 feet between centers. Eventually each tunnel will contain one track. The bore is straight, with a knee at either end, due at the north end to the proximity of the Rhone River at the town of Brigue and at the Southern extremity to the nearness of the Divernia, just below the town of Iselle.

The track at the north portal is about 2,250 feet above sea-level. From this point the tunnel rises with a 2 per cent. grade until the apex is reached almost exactly beneath the boundary between Swiss and Italian territory. This highest point is about 2,325 feet above the sea, and the bore falls thence with a 7 per cent. grade to the southern entrance, at an altitude of about 2,100 feet. The mountain over the tunnel is 7,000 feet in height and the thickness of rock above the tunnel at the apex is greater than anything ever before attained.

The method of building provided for the completion of the easterly tunnel as it is driven, while simultaneously only the floor heading of the second or western tunnel was carried along. The two bores are joined at intervals of about 650 feet by cross-galleries or traverses. While the two tunnels will ultimately be of the same size, it is the plan to finish but one at the present time, and enlarge the second at about the middle for a distance sufficient to permit trains to pass. When traffic increases so as to demand it, the second bore will be fully completed. An especial advantage of the double tunnel scheme developed in course of construction, in permitting a very effective system of ventilation. A very high temperature was encountered as the work progressed

and in order to make conditions more tolerable, fresh air was forced in by powerful fans at the rate of about 1250 cubic feet per second, entering heading No. 2, passing through the last traverse and returning outward through heading No. 1. Cross-galleries or traverses were closed as the work progressed, only the advance opening being kept clear. Even with such a circulation as this, it was found necessary to still further reduce the temperature at the face by sprays of cold water and for this purpose a great system of refrigeration was installed. The temperature of the rock in the tunnel was 55° cent., but the cooling devices maintained the air temperature at from 25° to 30° cent.

The construction of the tunnel was carried on simultaneously from both ends. The heading starting on the Swiss side at Brigue was pushed beyond the apex to a point on the Italian side about 6½ miles from the Swiss portal. At this time the Italian heading had been advanced to within about 800 feet of the other heading and there remained this thickness of rock to be penetrated before the mountain was pierced. At this point, in September, 1904, unexpected obstacles to further progress were encountered, necessitating the abandonment of work on the Swiss side and seriously impeding operations in the Italian heading. These were springs of hot water at 45° cent. opened almost simultaneously in the two headings; those on the Swiss side flowing about 489 gallons per minute, those on the Italian side 960 gallons per minute. The volume and temperature of this water in the Swiss heading, together with the destruction of the cooling plant for that section by a landslide, forced complete suspension of operations at that side. The work was completed by driving through the Italian heading, but here again operations were seriously impeded and the rate of progress cut down to a mere fraction of that normally maintained. When measurements showed that only a thin wall, which could be removed with one blast, intervened between the two headings, work was suspended until the greater part of the accumulated water on the Swiss side could be pumped out. Then the blast was fired, making an opening through which the remaining water rushed out to the Italian portal. This occured on February 24, 1905; and this date marks the culmination of the greatest tunneling enterprise ever attempted. The work was started in August, 1898.

Power for the Simplon work has been furnished by two plants of about 2000 H. P. each, driven by water power, one at either end of the tunnel. The method of tunneling was radically different from that familiar to American engineers and so often exemplified in tunnel work in this country. Instead of the compressed air rock drills so common in American practise, the Brandt system of hydraulic rock drills was used. Instead of chipping away the rock by hammer blows, it was ground away by cutters under tremendous pressure. Instead of the familiar air compressor plant, there were immense high pressure pumps driven by water wheels. The ventilating fans also are driven from water power. The tunnel section was enlarged by hand drilling.

But compressed air had its part in the enterprise, in operating the haulage locomotives handling construction trains in the tunnels. In the power house at Brigue, Switzerland, are two Ingersoll-Sargeant air compressors furnishing air for these motors. Both of these machines are belt-driven from water wheels and are of the style known by the makers as "Class BC 3." They are of the three-stage "straight-line" type, with water-jackets on the low pressure cylinder, horizontal intercooler, and water-box submergence on the high and intermeditate pressure cylinders. They deliver air at 1500 lbs. pressure and at normal rating of 140 R. P. M., each compressor has a free air capacity of 121 cubic feet per minute furnished at this pressure.

The continuation of this great work under the unexpected difficulties encountered called for the exercise of resource and daring on the part of the engineers in charge. The driving forward of the Italian heading in the steaming, stifling heat from the hot water was in itself a wearing and laborous operation without precedent. Much curiosity and apprehension was felt as to the outcome of the piercing of the dividing wall. But this was made without mishap and since that time efforts have been directed toward enlarging, lining, and completion of the tunnel.

While one of the largest and most difficult tunnels, the Simplon was by no means the most expensive. Its cost thus for, exclusive of installation charges, have been about $210 per lineal foot. In driving it, ten thousand men have been continuously employed—four thousand on the Swiss side, six thousand on the Italian section. Its length, as stated, is 12¼ miles. The section of the completed tunnel is of horse-shoe shape, 13½ feet wide at bottom, 16½ feet at starting line and 18 feet high in the clear above the rails. It is lined with concrete and masonry throughout, the enormous pressure in some places calling for a lining 6 foot in thickness. The heading carried forward in the second and uncompleted bore, is 6½ feet high and 10 feet wide. Just what power will be used to haul trains through the Simplon Tunnel has not yet been made public. But a recent order by the Swiss government for 160 cars with enclosed platforms seems to indicate that, for the present at least, steam will be used.

*Hand Cars**

Considering the great extent to which it is necessary to use hand cars for the maintenance of track, and the character of the service for which they are used, it is evident that a good hand car is essential for economical management, and that hand cars used by the Maintenance of Way Department should be designed and constructed to best meet the requirements, and be carefully

*Read before the Roadmasters' and Maintenance of Way Association at the twenty-third annual convention, Niagara Falls, N. Y., Sept. 12-14, 1905.

used, properly inspected and kept in good order

To meet the requirements, hand cars should be well made, using best material available, strong enough to carry 3 to 10 men and tools required safely, light enough so that two men can remove it from the track quickly when necessary to do so to clear track for an approaching train, and as easy running as it is possible to make them and not sacrifice durability.

Hard and slow running hand cars cause a useless expenditure of energy and a loss of time, and as the price of labor is constantly inceasing, it causes a corresponding increase in loss of money.

It is important, therefore, that the hand cars should be in as easy running condition as it is possible to have them at all times, and as a good car will get out of order quickly if improperly or carelessly used, all foremen should be fully instructed for what purposes it may or may not be used, and cautioned against careless handling.

The uses to which hand cars should be limited should be as follows.

For taking men with tools required to and from work.

For making daily patrols for the inspection of tracks, bridges, fences, etc., and for carrying ties or rails, or other heavy material in an emergency when track is unsafe for use and push car is not available.

Hand cars should be properly taken care of at all times, and when not in use, they should be stored in houses provided for that purpose. A lock and chain should be carried on hand cars at all times and when it is left out of sight it should be locked to prevent its being used by unauthorized parties, and when extra cars are held, which are not in service, they should be locked and lever removed and stored in tool house.

It should be kept well oiled at all times to have it run easy and prevent wear of bearings.

When it is set off from the track, a good level place should be selected so that all wheels will rest evenly on the ground to prevent car from warping.

When putting it on or off from track the wheels should not be allowed to strike hard against the side of rail, as the wheel is liable to be injured, the axle sprung, or the boxes moved out of place, which cause the wheel to crowd the rail and run hard.

Hand cars should not be used for transporting heavy track material except in cases of emergency, and then care should be taken that it is not overloaded, and that it is loaded and unloaded carefully.

Each hand car should be limited to the number of men it is safe to carry, based upon standing room, and this number should not be exceeded.

No matter how carefully hand cars are used or constructed, however, they are liable to become unsafe for operation at anytime and will be in need of repairs eventually, and as to the best way and means of keeping them in repair your committee makes the following suggestions:

That each morning before starting out, the foremen should inspect their hand cars and know that they are safe to run.

When a hand car is found out of repair, the foreman should make a report to his superior immediately, stating fully what repairs are required to put the car in good order, and if defects are found which render the car in any way unsafe, it should not be used.

The Supervisor or Roadmaster to whom this report was sent should hold such original report and also a record showing when received, and when and by whom repairs were made.

That each hand car be given a number which should be stencilled on car, and that this number should be used at all times when reporting or referring to it, as otherwise no reliable record can be kept of each car.

As section foremen are not experienced hand car builders, it is policy to provide a regular hand car inspector who should go over the line with a velocipede or speeder and inspect all cars in the territory assigned to him at least once every two months, and make such repairs as he can, and if he cannot make the repairs required, to order it sent to the shop.

The inspector should be appointed by the head of departments having charge of hand car repairs.

The inspector should report to his superior the nature of defect of each car sent in for repairs, and a copy should be forwarded to the head of department under which the car was used.

The department having charge of hand car repairs should furnish a statement each month to the department for whom hand cars have been repaired, showing the cost of repairing each car during the month.

That a record be kept of the amount expended for repairs of hand cars on each section or gang, and when the cost is considered above the average with no apparent reason why, the foremen should be notified of the fact and steps taken to insure proper care and usage.

That it is policy to assign a hand car to each gang, and that the foreman be given to understand that this car was to remain on his section and when it is sent to the shops for repairs, it should be returned again as soon as repaired.

As hand cars are liable to be damaged when being returned from the shop, by careless handling by either train or warehousemen, and to save expense of transporting them back and forth, it is policy to have a floating gang to repair hand cars, where sections are short and several hand cars are located at each station and train movements are frequent enough to allow it to get over the terrifory assigned to it once every three months.

Whenever hand cars are returned from the shop which have not been repaired properly, the foreman should report the fact to the head of his department at once.

F. M. RUMMEL, L. S. & M. S. RY., Chairman.
J. O'LAUGHLIN, A. A. RY.
TIMOTHY HICKEY, M. C. RY.
FRANK M'DONALD, C. B. & Q. RY.
JAMES SWEENEY, C. & E. I. RY.
PAT SCANLIN, C. & N. W. RY.

Committee.

Personals

Mr. R. C. Johnson has been appointed division engineer of the Tidewater Railway at Norfolk, Va.

Mr. F. R. Layng has been appointed engineer of bridges of the Bessemer & Lake Erie at Greenville, Pa.

Mr. A. B. Crook has been appointed roadmaster of the Wharton district of the Galveston Harrisburg & San Antonio.

Mr. John C. Bentley has been appointed assistant engineer of the New York Ontario & Western at Middletown, N. Y.

Mr. H. W. Duvall has been appointed supervisor of bridges and buildings of the Nashville division of the Illinois Central at Princeton, Ky.

Mr. John M, Egan, Jr., roadmaster of the Illinois Central at Freeport, Ill., has been transferred to Nashville, Tenn., in a similar capacity.

The office of Mr. C. A. Chandler, assistant division engineer of the Missouri Pacific at Atchison, Kan., has been transferred to Omaha, Neb.

Mr. S. B. Kellar has been appointed signal supervisor on the Philadelphia division of the Baltimore & Ohio, vice Mr. T. McCambridge, resigned.

Mr. C. M. James, heretofore acting engineer of roadway of the Atlantic Coast Line, has been appointed engineer of roadway, with office at Wilmington, N. C.

Mr. C. F. Gehring has been appointed general foreman of bridges and buildings of the Missouri Kansas & Texas at Parsons, Kan., in place of Mr. A. Dennison, resigned.

Mr. L. H. Wheaton has been appointed chief engineer of the Halifax & Southwestern, with office at Bridgewater, N. S., in place of Mr. T. H. White, assigned to other duties.

Mr. A. E. Harvey, division engineer of the Indianapolis Southern, has been appointed division engineer of the St. Louis Iron Mountain & Southern at Little Rock, Ark.

Mr. Robert Melrose, formerly roadmaster of the Michigan division of the Cleveland Cincinnati Chicago & St. Louis, died at Wabash, Ind., on December 4, aged 70 years.

Mr. H. P. Mobberly, formerly assistant engineer of the Texas & Pacific, has been appointed chief engineer of the Louisiana East & West Railroad, with headquarters at Bunkie, La.

Mr. L. F. Lonnbladh, heretofore chief engineer of the Tennessee Central, has been appointd assistant superintendent of construction of the Southern Railway, with office temporarily at Nashville, Tenn.

Mr. H. A. Schwanecke has been appointed superintendent and chief engineer of the Kansas Southern & Gulf, in charge of maintenance and construction, with headquarters, temporarily, at Marshall, Ill.

Mr. G. B. Mitchell, assistant engineer of the Canadian Pacific at Montreal, Que., has been appointed superintendent of buildings of the New York New Haven & Hartford, with headquarters at New York.

Mr. W. L. Darling, who was recently appointed chief engineer of the Pacific Railway, a part of the coast extension of the Chicago Milwaukee & St. Paul, has resigned to accept a position with another company.

Mr. G. L. King has been appointed right of way agent of the Pacific system of the Southern Pacific Company, with headquarters at San Francisco, Cal., vice Mr. T. J. Wilson, assigned to other duties, effective on December 1.

Mr. W. S. Harer has been appointed division engineer of the Idaho division of the Oregon Short Line at Pocatello, Idaho, succeeding Mr. J. P. Congdon, who has been appointed supervising engineer of operated lines under the chief engineer.

Mr. W. R. Armstrong has resigned as superintendent of construction of the Kansas City Mexico & Orient at Chihuahua, Mex., to accept a position as assistant engineer under the chief engineer of the Oregon Short Line at Salt Lake City, Utah.

Mr. F. A. Molitor, chief engineer of the Midland Valley, with office at Saint Louis, Mo., has been appointed supervising engineer of the Philippine commission, which is to have charge of the construction of new railroads in the Philippine Islands.

Mr. J. P. Hannah, assistant roadmaster of the Knoxville division of the Southern, has been appointed roadmaster of the Nashville division at Nashville, Tenn. Mr. W. G. Lacey succeeds Mr. Hannah as assistant roadmaster at Knoxville, Tenn.

Mr. P. F. McDonald has been appointed roadmaster of the South & Western Railway at Johnson City, Tenn., with jurisdiction from Johnson City to the end of the track. He will also have charge of all new tracklaying southward from the present end of track near Tee River bridge.

Mr. Robert Moore has been chosen consulting engineer of the Municipal Bridge and Terminals Commission of Saint Louis, Mo., which is to consider plans for extending the present terminal facilities of the city so as to avoid the congested conditions which usually arise at busy seasons of the year.

Mr. W. S. Dawley, engineer maintenance of way of the Chicago & Eastern Illinois, has been appointed chief engineer, with headquarters at Chicago. Mr. R. H. Howard, principal assistant engineer, has been appointed to succeed Mr. Dawley as engineer maintenance of way, with office at Chicago.

Mr. J. D. Trammel, chief engineer of the International & Great Northern, having been given an indefinite leave of absence on account of illness in his family, that office has been abolished. Mr. O. H. Crittenden has been ap-

pointed resident engineer in charge of the engineering department, with headquarters at Palestine, Tex.

Mr. E. P. Dawley, heretofore assistant chief engineer of the New York New Haven & Hartford, has been appointed engineer of construction, with headquarters at New Haven, Conn., and the former office has been abolished. Mr. W. J. Black has been appointed engineer maintenance of way, with office at New Haven. The office of assistant engineer has been abolished.

Mr. David M. Boyd, secretary to Vice-President B. D Caldwell of the Lackawanna railroad, has been appointed contracting agent of that road, in which position he will become a member of the staff of the general eastern freight agent, with headquarters at 429 Broadway, New York. Mr. Boyd is a graduate of Yale of the class of 1899. His promotion is a well-earned recognition of his energy and ability since he became identified with the Lackawanna railroad, six years ago. The appointment is effective December 1.

It is officially announced that Mr. John D. Isaacs has been appointed consulting engineer for the completed lines of the Union Pacific, Southern Pacific, Oregon Short Line and Oregon Railroad & Navigation Company in matters relating to construction and maintenance of bridges and buildings, signaling and preservation of timber, with headquarters at San Francisco, Cal. He will also handle, for the director of maintenance and operation, questions relating to standards and costs of work, and such other matters as may, from time to time, be prescribed, effective on December 1.

The following appointments on the Western Pacific have been announced by Vice-President and General Manager Virgil G. Bogue: Mr. H. M. McCartney, principal assistant engineer, with offices at San Francisco, Cal.; Mr. John T. Williams, division engineer at Oakland, Cal.; Mr. Emery Oliver, division engineer at Oroville, Cal.; Mr. James Q. Jamieson, division engineer at Elko, Nev.; Mr. Charles Harlowe, division engineer at Winnemucca, Nev.; Mr. T. J. Wyche, division engineer at Salt Lake City, Utah; Mr. J. C. Havely chief clerk engineering department, and Mr. J. B. Wallace, engineer right of way, both at San Francisco.

Mr. R. V. Massey has been appointed supervisor of the Pennsylvania Railroad at Pittsburg, Pa., vice Mr. A. B. Clark, who has been appointed assistant division engineer of the Philadelphia & Erie Grand division at Renova, Pa., succeeding Mr. D. R. Mehaffey, transferred to the office of the chief engineer of maintenance of way. Mr. W. B. Carpenter, heretofore supervisor at Hollidaysburg, Pa., has been transferred to Freeport, Pa., in a similar capacity, in place of Mr. P. L. Reed. Mr. C. W. Montgomery has been appointed supervisor at Hollidaysburg to succeed Mr. Carpenter. Mr. N. W. Smith has been appointed supervisor in the office of the principal assistant engineer at Altoona, Pa., to succeed Mr. W. H. Johnson, Jr., resigned. Mr. M. I. Ward, heretofore supervisor at Blairsville, Pa., has been appointed super-

A 70-TON BUCYRUS SHOVEL AT WORK IN THE PANAMA CANAL CUT. MR. FRANK H. SAMPSON, CHIEF OF THE COMPANY'S ERECTING STAFF, IS SHOWN IN THE FOREGROUND IN A WHITE SUIT

visor at Harrisburg, Pa., in place of Mr. Smith. Mr. C. S. Heritage, supervisor at Irvona, Pa., has been transferred to Blairsville, Pa., succeeding Mr. Ward. Mr. W. S. Wilson, heretofore assistant supervisor, has been appointed supervisor at Irvona, Pa., in place of Mr. Heritage.

Panama Steam Shovels

A few of the old French excavators are being operated in the Culebra cut, but the great work of excavation is to be accomplished by powerful American steam shovels. Sixty-one of these have been ordered by the Isthmian Canal Commission for this work, all of which are being furnished by The Bucyrus Company of South Milwaukee.

The contracts under which the machines are furnished provide for delivery and test at Culebra, Canal Zone, and the company have two of their erecting engineers, Messrs. F. H. Sampson and B. H. Gabriel, upon the ground to superintend this work. Seventeen of the shovels are already in operation upon the Isthmus and are giving substantial demonstrations of their superiority over the old French excavators of the elevator bucket type.

Of these seventeen shovels now at work, eight are 95-ton machines with five-yard dippers, and remaining are the well-known Bucyrus seventy-ton shovels, with 2½ yard dippers.

The 95-ton is the most powerful steam shovel ever built, and machines of this type have operated at the rate of 818 yards per hour in heavy material, and one of these shovels working on the Southern Pacific Railway excavated and loaded 32,000 yards in one week of six days, working only ten hours per day, and with continual delays on account of shortage of cars and lack of ample switching facilities.

The 70-ton shovel, of which The Bucyrus Company is furnishing nine for the canal work, is probably the most widely known and used machine of its class in the world, and the fact that practically no deviations from the standard 70-ton shovel were required by the Commission, on account of the exacting nature of the Panama work, speaks volumes for the general excellence of the machine. Shovels of this size have frequently operated at rates of from 400 to 450 yards per day, and one 70-ton Bucyrus shovel owned by the Chicago, Milwaukee & St. Paul Road has excavated and loaded 22,386 yards of heavy clay in one week of six consecutive days, although the machine was idle over one quarter of the time.

Steam shovels of this type are in very general use in the iron mines of Michigan, Wisconsin and Minnesota, and we have heard that of twenty-seven new shovels required for last season's work on the iron ranges, twenty-five were ordered from the company that furnishes the Panama shovels.

The steam shovels are built entirely of steel and iron. Even the houses or coverings to protect the machinery are of sheet steel. On each side of the shovel the main operating machinery comprises a powerful locomotive boiler, giving steam to three sets of engines. Immediately in front of the boiler are placed the main hoisting engines which drive through a belt friction clutch, the drum after raising and lowering the dipper. To the left of the main engines are a pair of smaller ones direct-connected to a drum upon which are wound the swinging cables for swinging the boom and dipper from side to side in digging and loading cars. The shovels propel themselves by sprocket chains attached to both trucks. These are also driven by the main engines. All this machinery is mounted upon a car body which is composed of four parallel I-beam sills. The boom and dipper handle at the forward end of the shovel are built entirely of steel. A powerful engine is mounted upon the boom and drives an intermediate or shipper shaft, upon which are keyed two pinions which mesh in rack upon the end side of the dipper handle and so thrust the dipper up to its work.

A crew of three men is required to operate the machine, that is, an engineer and a cranesman, who is mounted upon a platform on the boom to operate the boom engines and dump the dipper. The third man is the fireman, stationed at the rear of the shovel, for firing the boiler. A crew of from four to six laborers, at least, are always employed about the shovel for setting the short-rail sections upon which the shovel stands, clearing away debris, etc.

The illustration gives very inadequate representations of the construction of the steam shovels and also of conditions on the Isthmus under which they are at work. The attention of the reader is especially called to the construction of the booms upon these machines; both the 70-ton and 95-ton booms showing to good advantage the heavy construction which is employed in these machines.

The company supplying the steam shovels are also extensive manufacturers of railroad wrecking cranes and pile drivers, as well as dredging machinery of every type. They are, without question, leaders in the development of the modern placer dredge. Nearly one-thousand men are employed at the extensive and up-to-date plant of the Bucyrus Company at South Milwaukee, Wis.

Reliance Hydraulic Jacks

The "Reliance" hydraulic jacks have some points of construction that are of interest to the user of those appliances, for the reason that they mean ease of manipulation as well as certainty of action. They are a long-lived tool, owing to the fact that no abrasive substance can effect an entrance to the cylinder through the dust-proof stuffing box. The lowering device, when under a load, is one of the simplest things ever applied to a jack, since it enables the operator to lower the load from one-quarter of an inch to the limit of the ram length by simply giving a thumbscrew a half turn. Besides these features, which give it an added efficiency, the lever may be applied in any one of four ways, and the jacks work horizontally as well as vertically, two points of excellence that should make the tool an ideal one for wrecking purposes. They are made by Philip S. Justice & Co., Philadelphia, Pa.

Notes of the Month

The Buda Foundry & Mfg. Co., Railway Exchange, Chicago, have issued their catalogue on track drills. This deals with the Paulus track drills, with automatic feed, Buda pattern track drill, Paulus girder drill, Wilson drill, Harvey drill, Rich spindle, chuck and flat drill bit, together with list of repair parts and prices for all the different makes they handle.

It is said that work will be started soon on the electrification of the West Shore road between Rochester and Syracuse, which will make a stretch of 81 miles, which is assumed to be the preliminary move toward electrification of the entire line. If this assumption is correct the work will be the pioneer project in changing a trunk line from steam to electric power. The work now about to be undertaken is to be completed by March 1, 1906.

Mr. Edward Winslow Ames, United States charge d'affaires at Santiago, Chili, advises the department of state that the government of Chili has included the United States among the countries in which bids are to be solicited for the building of certain dredges required by that government. The specifications for the dredges have been forwarded to Senor Don Joaquin Walker-Martinez, the minister from Chili, at Washington.

The purchase of the Missouri, Kansas & Texas railroad by the Hill interests, and the prospect that the Canadian Pacific will

also become a part of the great system controlled by James J. Hill and his associates, will probably result in the completion of extensive plans for freight terminal facilities in Clay county, across the Missouri from Kansas City. The Burlington railroad, which is a Hill controlled line, has some exclusive holdings in Clay county, besides a one-third interest in the 3,500 acres owned by the Armour-Swift interests.

The Pennsylvania road is making the attempt to grow the timber from which to draw on for its supply of track ties, already having planted over 400,000 yellow locust trees, and it is to plant 800,000 more of the same. The heavy drafts made on tie timber by this road are such that individual effort alone will not begin to supply its needs, but it is doing all possible to aid the cultivation of this class of timber, which is called upon to furnish 3,000,000 ties per year for repairs alone, besides some 500,000 for new construction. Locust is thought to give a better service than oak owing to its toughness.

The Board of Directors of the Pennsylvania road has authorized improvements which it is estimated will cost $5,000,000. These improvements were recommended by the Road Committee of the Board, and include the completion of a double track west of Harrisburg, between Ryde and Mount Union, besides a change of grade on the middle division, and four-tracking the Pittsburg division between Bolivar Junction and Sang Hollow, a distance of fifteen miles. At this meeting, the directors also passed a resolution indorsing President Cassatt's action touching the transportation question, which contemplates the issuance of passes only to officers, directors, and employes of the Pennsylvania road and connecting lines.

The Bucyrus Company has lately received a number of large and very important contracts. It is furnishing all the steam-shovels, railroad wrecking-cranes and pile-drivers that have yet been ordered by the Isthmian Canal Commission for constructing the Panama Canal. These represent a total of sixty-one steam-shovels, three wrecking-cranes and one pile-driver, some of which are now at work in Panama while others are in process of manufacture. This Company is also building shovels for the principal railroads and contractors of the country and already has a number of contracts for furnishing steam-shovels, for use next spring, to the iron companies of Minnesota.

The need of uniformity in track gauge in Brazil has awakened the railways of that country to decisive action by which equipment may be interchanged and through traffic suffer no more the inconvenience and loss due to transfers and breaking of lading while in transit. When the gauges are made uniform there will be an uninterrupted line between Rio Grande du Norte, Parabyba, Pernambuco, and Alagoas. It is but a few years ago that United States interstate commerce was strangled from the same cause that Brazil is now about to free herself from, and the strange part of the situation, as it existed here, was that many expedients were resorted to in order to avoid the inevitable change of gauge. Heroic treatment solved the problem in that case, as it will in the present instance.

The proceedings of the Railway Signal Association for 1905 were issued on Dec. 12. As is well known to those interested in this most important branch of railway service, these reports are replete with literature of the most valuable and interesting character. The various committee reports and papers written during the year are published, together with all of the discussions relating thereto, embodying also the discussions on lights, rubber-covered wire, standard mechanical specifications, storage battery installations, and many other details of signal construction and maintenance. These reports may be obtained of Mr. H. S. Balliet, Secretary and Treasurer of the Association, 335 Madison Ave., New York City. The price is 25 cents per copy.

The completion of the Suakin-Berber Railway is the latest announcement of finished railroad work in Eastern Africa. This line taps the Soudan country at Berber, and extends 250 miles northeast to Suakin on the Red Sea, by which means the economic independence of the Soudan is assured, and the project is therefore one of the greatest importance to that region, which has languished for the want of rail communication to the sea. This route is a natural outlet for the country which it taps, and Suakin is the logical port for the road. Khartoum, which lies about 200 miles southwest of Berber, has a line of railway which has not been a success commercially, since it was not able to divert trade to unnatural channels. The new line will not suffer from this influence, and is expected to open up an immense business from the start.

The general manager of the Rio de Janeiro Tramway, Light and Power Co. (Limited), is Mr. F. A. Huntress, formerly general manager of the Worcester Consolidated Street Railway Co., of Worcester, Mass. Mr. James Mitchell, for many years the chief representative of the General Electric Co. in Brazil, and more recently manager of the Sao Paulo Tramway, Light and Power Co. (Limited), is chief engineer of construction. Mr. Mitchell is considered the leading electrician of Brazil. He and Mr. Huntress are citizens of Massachusetts. The legal representative of the company in Brazil is Mr. Alexander Mackenzie. The manner in which he has conquered the various formidable obstacles placed in the way of this important company augurs well for its future success.

The Browning square type automatic grab bucket is for digging ashes, coal, cinders, city refuse, crushed stone, ballast, grain, gravel, mud, ore, sand, salt, slag, sawdust or any other material usually handled by an opening and closing device. This bucket is operated by two independent ropes, one of which does the hoisting and closing, and the other, which is the suspension and opening rope, may be operated from a power drum or actuated by an idler drum with brake and counter-weight. This bucket handles with equal facility from any crane having a hoisting apparatus. The shells are made of the toughest steel plates, while all of the working parts are of hard-drawn steel. Bulletin No. 21 of the Browning Engineering Co., Cleveland, O., showing this bucket in operation, may be had free upon request.

The rapid increase in electric railway building is well shown in the remarkable record made in Germany during the past nine years. The "Electrotechnische Zeitschrift" has given some data in this connection which is interesting and from which is selected the following:

Years when built	1896	1900	1903	1904
Number of main centers of electric railway systems	42	99	134	140
Length of roads in miles	361	1,781	2,293	2,354
Length of single track in miles	530	2,642	3,415	3,521
Number of motor cars	1,571	5,994	8,702	9,03[illegible]
Number of trailers	989	3,962	6,190	6,47[illegible]
Capacity of electric machines in K. W.	18,500	75,608	133,151	133,326
Capacity of storage batteries in K. W.		16,890	38,730	39,800

From the values above it is gathered that while the increase of main electric centers has been but 3.33 times in the period covered, mileage, motor equipment and power in K. W. have increased substantially at a seven-fold rate.